



GPS-Enhanced Onboard Navigation System (GEONS)

Open architecture solutions for onboard orbit determination



NASA Goddard Space Flight Center invites companies to license its GEONS flight software package that provides onboard orbit determination and control in real time, with higher accuracy, without human intervention, and while requiring minimal onboard computing resources. It substantially improves definitive and predictive accuracy of Global Positioning System (GPS) receiver point solution fixes, achieving accuracies of at least 20 meters and 3 cm/sec.

GEONS was developed by researchers at Goddard to meet technology needs for: increased satellite autonomy, support for collaborative science missions, GPS navigation to satellites with limited GPS visibility (e.g., high-Earth and geosynchronous missions), and proposed formation flying/constellation missions.

Benefits

- **Increases accuracy:** Reduces navigation errors by a factor of 15 in position and a factor of 50 in velocity when compared to traditional receiver solutions
- **Improves reliability:** Can produce highly accurate orbit estimations even when only one GPS satellite is visible, greatly improving reliability for many applications
- **Reduces mission cost:** Eliminates the need for ground-based orbit determination and tracking, while still allowing accurate ground-based monitoring and planning
- **Enables satellite formation flying:** Enables advanced mission concepts such as satellite formation flying
- **Reduces computing requirements:** Requires minimal processing power, operating within limited onboard computer resources
- **Improves stability:** Processes data used for other spacecraft functions, increasing stability and reliability and enabling graceful degradation should a component fail

Applications

GEONS can be incorporated into science and technology applications including

- HEO/LEO/GEO satellites
- Spacecraft

Technology Details

While real-time positioning computed by standard GPS service is adequate for some onboard applications, inherent position discontinuities are not acceptable for high-precision instrument applications, such as view-period prediction and maneuver planning, both of which are computations that require a continuous prediction of the spacecraft state. Real-time positioning also requires simultaneous measurements from four GPS satellites, a mission-limiting factor that must be considered.

How it works

GEONS processes data from standard GPS receivers, onboard communication equipment, and/or attitude sensors, producing accurate absolute and relative navigation solutions in real time. Other functions, including onboard maneuver control and relative navigation for keeping formations are also supported by GEONS. All information is quickly available to scientists when it is included in the down-linked telemetry stream.

GEONS provides high-quality solutions with fewer than four visible GPS space vehicles by employing an extended Kalman filter (EKF) augmented with physically representative models for gravity, atmospheric drag, solar radiation pressure, clock bias, and drift to provide accurate state estimation and a realistic state error covariance. GEONS incorporates the information from all past measurements—carefully balanced with GEONS’ data of the physical models governing these measurements—to produce an optimal estimate of the user spacecraft’s orbit. GEONS’ high-fidelity state dynamics model reduces sensitivity to measurement errors and provides high-accuracy velocity estimates, permitting accurate state prediction during signal outages or degraded coverage.

Autonomous navigation reduces total mission cost by eliminating the need for routine, ground-based orbit determination and special tracking services, and it is required for advanced mission concepts, such as satellite formation flying. GEONS was designed for autonomous operation within the very limited resources of an onboard computer. Autonomous initialization and enhanced fault detection capabilities are implemented using instantaneous geometric GPS solutions.

Why it is better

By incorporating information from past measurements, GEONS provides highly accurate orbit estimates even with one visible GPS space vehicle—and even during signal outages or degraded coverage. This unprecedented accuracy and reliability reduces navigation errors and does it autonomously with minimal onboard computer resources.

Additionally, GEONS processes Doppler measurement data from onboard attitude sensors. These different types of measurements are all incorporated into the GEONS software, producing a navigation system capable of handling multiple orbit regimes and navigation subsystems, while requiring no additional hardware. Fusion of these data types increases system stability and reliability and enables graceful degradation in the event that a component fails during orbit.

Licensing and Partnering Opportunities

This technology is part of NASA’s Innovative Partnerships Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing the GEONS Software (GSC-14687-1) for commercial applications.

For More Information

If you are interested in GEONS (GSC-14687-1), please contact:

Office of Technology Transfer
NASA Goddard Space Flight Center
geons@gsfc.nasa.gov

More information about working with NASA Goddard’s Office of Technology Transfer is available online:

<http://techtransfer.gsfc.nasa.gov>